

Implementation of Lean Construction in Construction Industry of Pakistan

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Date: _____

*This thesis is dedicated to my parents, respected teachers, my wife, my
newly born daughter and colleagues!*

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ABSTRACT

The construction industry is one of the important sectors of the country; it needs some improvements in its thinking, processes and way of workings so that it can add value to money and customers. The purpose of this study is to examine the current challenges of construction industry and propose a road map for the implementation of lean construction in Pakistan to address them. Literature review presents that worldwide construction industry faces problems in project delivery and how lean is adding value and increasing client satisfaction. Hurdles faced in implementation of lean in construction industries of the world and the way they coped with them is assessed through questionnaire survey. Findings reveal that wastage, time and cost overrun are the biggest reasons that necessitate lean construction implementation. The respondents stated that after application of lean construction, issues have been mitigated. Human reluctance has been found to be the biggest challenge and suggested that creating awareness of lean construction is the most beneficial in its implementation. Considering the data from questionnaire survey, interviews from senior management of Pakistani construction firms were conducted to find out what possible hurdles can be met in implementing lean construction in Pakistan and their possible solutions. Findings reveal that lack of knowledge is the major hurdle in its implementation in Pakistan and suggested that Pakistan Engineering Council (PEC) should play a role in its awareness. Trainings and seminars, reducing academic-industrial gaps, adoption of lean culture, standardization in construction processes, value oriented approach and appreciation of use of modern tools can facilitate the lean implementation in Pakistan. PEC should engage a team of experts

to train professionals and by personal meetings, encourage the organizations to introduce lean construction in their processes. Once the construction industry starts reaping its benefits maintain the change.

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INTRODUCTION

1.1 INTRODUCTION

The infrastructure growth is a measure of country's economy. Construction is considered to be one of the major contributors in economic growth. It upgrades the standards of people by providing them facilities like roads, schools, hospitals, etc.(Memon et al., 2011).The construction industry provides job opportunities as well as development of affiliated sectors such as cement, steel, glass industries, etc. and helps reduction in poverty of people.

As far as construction sector of Pakistan is concerned, it is the second largest contributor to country's economy after agriculture. Almost 30-35% of people are employed in the construction and associated sectors (Farooqui & Ahmed, 2008). Many mega projects are in progress these days, e.g. Bhasha Dam, Neelum Jhelum Hydropower Project, China-Pakistan Economic Corridor, Gulpur Hydropower Project, etc.

Unfortunately, construction industry of Pakistan has not grown enough in the manner that it can adopt new technologies or new ideas related to construction, as being implemented in other parts of the world. People in the industry are still comfortable with the conventional methods they are using since years. There is no paucity of talent in Pakistan even in construction sector. But due to under developing nation, it will take years to understand that where the industry is headed and where it ideally should. The construction industries of other parts of the world are adopting

new technologies and ideas in construction such as lean construction, Total Quality Management and Building Information Modeling, etc. But Pakistan is still using old traditional methods to build even the mega projects. This is the reason why every 9 out of 10 projects get delayed or over budgeted (Nawaz et al., 2013). Quality assurance in industry is negligible; stakeholders always take it for granted and they compromise the quality against the cost constraints. Application of project management principles is very poor due to either unawareness or lack of willingness. People are educated but they are unaware of non-conventional methods to drive the project. They hardly apply safety in their projects because of lack of commitment, non-incorporation of safety budget in bid, lack of regulation, etc. Safety aspects are not even considered in design, resulting into project failure. There is lot of waste in the processes: waste of effort, time, talent and materials. Workers in the industry do not enjoy friendly, cooperative and healthy environment for working, they lack coordination between each other resulting into low efficiency. There is usage of inappropriate tools and ill thought out measures of performance in the industry, wasting the effort of people. A person in construction industry in Pakistan normally works seven days a week including Sunday. This leads to the overstress, more chances of error and loss of productivity (Pencavel, 2015).

1.2 PROBLEM STATEMENT

The slow pace of growth, higher volumes of waste, lack of productivity, non-committal attitude towards safety, reliance upon traditional and labor-intensive techniques, corruption and malpractice are the worms affecting the well-being of construction industry of Pakistan. In a situation like that, one philosophy stands out as a potential savior: Lean Construction.

Examining the implementation of lean construction in United Kingdom, United States of America, Brazil, etc. and the benefits that construction industries of those countries have reaped, it is suggested that philosophy of lean construction serves the purpose of evolving the construction industry. Application of lean in construction industry of Pakistan's expected to revolutionize the mindset of all the stakeholders and can seriously benefit the industry and ultimately economy of the country. Lean construction can reduce the waste in the industry by changing the process of working, appreciating the modern technology; revolutionize the management process and appreciation of creative thinking of people. This research aims to propose ways to revolutionize the construction industry of Pakistan by implementation of Lean philosophy in construction processes by understanding the challenges associated with it.

1.3 RESEARCH OBJECTIVES

- a. To study the prevailing issues in construction industry.
- b. To investigate the world-wide implementation of lean construction.
- c. To investigate the hurdles in implementing lean constructions in Pakistan's construction industry.
- d. To suggest the practical solution for implementing lean construction in Pakistan's construction Industry.

1.4 SCOPE OF RESEARCH STUDY

This study attempts to clarify the extent to which the various countries of the world have acquired lean construction and to what extent they have contributed to the construction industry. This research will focus on various approaches related to lean

implementation that can advance the construction processes. Countries like United Kingdom, United States of America, Canada, Turkey, Oman and etc. are reaping the benefits of lean construction application, Pakistan should get benefit as well.

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter aims to discuss the different aspects of lean construction and why this topic is being discussed, by understanding the problems in construction industry of Pakistan. It will present the thorough knowledge of lean construction, its origin, principles, different tools, and its application and payback in the construction industry in other parts of the world. This chapter will further converse that how its use in present traditional construction environment of Pakistan makes it helpful in coping with the current issues of construction industry. This is the fact that infrastructural development of any country is the measure of its economic growth. This chapter will elaborate the benefits that construction industry of Pakistan could achieve by adopting the new construction management philosophy i.e. lean construction.

2.2 CHALLENGES TO CONSTRUCTION INDUSTRY

The issue of untimely completion of the projects is worldwide and is the most persistent phenomenon of construction industry besides of the fact that time is of essence in the project management. Time over run has gained global importance; Vietnamese government is seriously concerned about this issue especially in public projects (Le-Hoai et al., 2008). A study was conducted in Nigeria by (Amu & Adesanya, 2011) which found that only 24 projects out of 3407 were timely completed, while 1517 were late and 1812 projects were discarded. In Bosnia and Herzegovina 177 projects were studied and 48.6% of them were delayed (Žujo et al.,

2010). In Jordan 82% of the 130 public projects taken for study faced delays (Al-Momani, 2000). In KSA, 70% of the projects are delayed with an average delay of 10%-30% of contractual stipulated duration(Assaf & Al-Hejji, 2006). Similar study was conducted in Malaysia where 359 projects were taken out of which 301 projects belonged to public sector and 51 were private projects. The study revealed that only 18.2% of public sector and 29.45% of private sector projects were timely completed, with average delay of 49.71% (Endut et al., 2009). In Pakistan, 80% of construction projects get delayed. Delay in construction project leads to cost overrun, disputes, etc. Reasons for delay can be numerous i.e. late decision making, late payments, unrealistic time schedule, poor planning, lack of coordination between the project stakeholders, rework, poor management, design issues, etc. Same reasons may apply to the construction industry of Pakistan(Haseeb et al., 2011).

Cost overrun is a significant problem throughout the countries of the world however they differentiate each other in dynamics (Reina & Angelo, 2002). This issue is more common in underdeveloped countries where overruns sometimes exceed 100% (Azhar et al., 2008). Cost overrun has become a global issue (Abdul Rahman et al., 2013). All over the world, every 9 out of 10 projects face overruns up to the extent of 50 to 100% (Flyvbjerg et al., 2003). Top most over run factors include unstable cost of materials and machineries, material wastage, lowest bidding tendering process, inadequate project management, delays between design and procurement phases, poor cost estimation, rework, lack of planning and uncooperative government policies (Azhar et al., 2008). Many Thai companies failed because of having inability to control cost over runs (Charoenngam & Sriprasert, 2001).

The quality in construction industries has become a serious concern in order to fulfill the customer needs. Quality is one of the parameters for the project success. Construction cost can even be minimized by doing the right job in the first attempt and avoiding rework (Love & Irani, 2003). Considerable budget is assigned to construction every year, but due to low quality results, additional cost has to be spent for the removal of defects and maintenance (Memon et al., 2011). Quality is affected by inflation, unstable material prices, procurement, material selection, poor communication and poor on site supervision (Farooqui & Ahmed, 2008).

Waste in construction is inevitable. It can be reduced but cannot be made zero. Waste is directly associated with project's efficiency, cost, productivity and timely completion (Hussin et al., 2013). Waste contributes 30–35% of total production cost (Forsberg & Saukkoriipi, 2007). Almost 9% of the purchased material is wasted on site (Bossink & Brouwers, 1996). A relatively small percentage of total work hours are productive. In 1990 a study was done by Michael Pappas, sponsored by construction industry Institute which revealed that only 11.4 % of recorded work hours produce value. Similarly, in piping process it was less than 7.5 % (Forbes & Ahmed, 2010).

Several steps have been introduced in order to increase the health and safety standards in construction but still lot of requirement is required (Huang & Hinze, 2006). According to the International Labor Organization (ILO), 6000 people die every day due to work related accidents and diseases. Most of the accidents are caused because of unique nature of work, different site conditions, human factors and inadequate safety management (Abdelhamid & Everett, 2000). A larger share of work is performed by the human enhancing the chances of accidents. Most of the

construction firms in Pakistan lie between extremely unsafe to moderately unsafe working environment (58%). Working with old and inappropriate tools makes the construction nature unsafe (Farooqui & Ahmed, 2008). Table 2.1 presents the summary of issues identified in construction industry.

Table 2.1: Major issues in construction industry

Sr. No.	Major issues in construction industry	Reference
1	Time Overrun	(Haseeb et al., 2011; Le-Hoai et al., 2008)
2	Cost Overrun	(Azhar et al., 2008; Reina & Angelo, 2002)
3	Poor Quality	(Love & Irani, 2003), (Farooqui & Ahmed, 2008)
4	Wastes	(Forbes & Ahmed, 2010; Hussin et al., 2013)
5	Health and Safety Issues	(Huang & Hinze, 2006)
6	Rework	(Forbes & Ahmed, 2010)
7	Lack of Coordination between Stakeholders	(Nalewaik & Mills, 2015)
8	Lack of Client Satisfaction	(G. A. Howell, 1999)

2.3 ORIGIN OF LEAN CONSTRUCTION

Lean thinking is originated from the manufacturing industry. Lean production focuses on activities that do not add value and is first improved by reducing the cost of such activities. Moreover, it improves value-added activities through continuous

improvement (Koskela, 1992). Non value adding activities are the result of damaged practices, mismanagement, communication gaps, lack of regulations, inadequate decisions and etc. (Forbes & Ahmed, 2010). Lean cannot be reduced to a set of rules or tools. It must be approached as a system of thinking and behavior that is shared throughout the value stream (Diekmann et al., 2004). The success of Toyota production system is universally accepted. This success mainly is based on Lean Principles (Forbes & Ahmed, 2010).

Lean construction has been evolved from manufacturing. Manufacturing and construction are two different processes. There are characteristics which are similar in both processes; however, they are not totally identical (Abdullah et al., 2009).

(Forbes & Ahmed, 2010) stated that many studies identified this difference as an impediment for applying lean manufacturing to the construction. Some differences are as following:

- a. Construction projects are unique in nature where manufacturing is repetitious
- b. Manufacturing is done in indoor controlled environment, but construction projects are executed at different places varying the environment of workplace.
- c. Manufacturing is of short duration and construction projects are of relatively long duration and complex
- d. Due to change in workplace and uniqueness of the project, stakeholders are different, varying the working relations from one project to another
- e. Construction has temporary project based organizations

These differences modified the lean concepts according to the requirement before its application in construction industry (Abdullah et al., 2009).

The origin of adopting the techniques of manufacturing in construction started from 1890's where Frank Gilbreth, a father of industrial engineering, observed brick mason during bricklaying. He found non-value-added steps in his motion. He suggested certain changes to the work of brick mason, avoiding unnecessary motion and increasing productivity. No. of businessmen in US investigated the improvement in construction industry and formed U.S Business Roundtable. This roundtable further appointed Construction Competitiveness Committee to further explore the possible enhancements which can be presented to the construction industry. In 1983 the Construction Industry Institute (CII) was formed by the committee which was working for the better and improved construction industry. Afterwards Lauri Koskela and Glen Ballard formed International Group of Lean Construction (IGLC) was formed in an International conference in Helsinki, Finland in 1993. Lean Construction Institute (LCI) was formed by Ballard and Greg Howell in US in 1997. These organizations are working for the betterment and implementation of lean construction (Forbes & Ahmed, 2010).

2.4 LEAN CONSTRUCTION

Lean construction is a way to design production system to reduce wastes of effort, time and materials in order to produce the maximum possible value (LJ Koskela & Gregory Howell, 2002). Salem et al. (2005) stated that lean construction differs from the traditional approach as this is the production management approach, and very suitable for complex, uncertain and fast track projects. Lean construction is

all about the elimination of flow activities (Wastes or Non-Value Adding Activities) and enhancing the efficiency of transformation or conversion activities (Value Adding Activities) in any process (Senaratne & Wijesiri, 2008).

There are seven wastes identified by Shigeo Shingo, an industrial Engineer in Toyota Production System (Shigeo & Andrew, 1981). These wastes include overproduction, inventory, waiting, motion, transportation, rework, over processing (Forbes & Ahmed, 2010). Apart from these seven wastes (Muda), Mura (Unevenness) and Muri (Overburden) are also considered as wastes. Lean principles presented by Womack and Jones (1996) are to identify the value, value stream mapping, creating flow, establishing pull and continuous improvement.

Lean is not just a philosophy, which is far away from practical. Glenn Ballard developed the Lean Project Delivery System (LPDS) in 2000. It provides the complete solution of various problems encountered in Design and construction process (G. Ballard, 2000). Traditional project management considers the designer and constructor, two entirely different entities having altogether separate roles whereas LPDS considers the role of two parties as a continuum to meet three basic requirements including delivering the project, enhancement of value and reduction of waste (Koskela, 2000).

Following are the characteristics of LPDS as discussed by Forbes and Ahmed (2010).

- a. Downstream players are involved in planning
- b. Project Control does the job of execution
- c. Pull concept is used in the flow between different activities

- d. Variability is absorbed using buffers
- e. Learning is always given priority using the feedback loops in the process at every level

LPDS consisted of different phases which are overlapped and interconnected with each other to depict the inter-dependency between the phases. This interconnection of phases shows the importance of communication between the stake holders. The main phases of LPDS include project definition, lean design, lean supply, lean assembly and use. Planning and control are two important aspects of construction project; the Last Planner system (LPS) is used for this purpose in lean. The Last planner system is all about empowering the front-end workers to plan and schedule the process, so they become the Last Planner (H. G. Ballard, 2000). Foremen has the power to refuse the tasks assigned to them if they are not possible and practical (G. Howell, 1999).

LPS authorize the last planner to plan about the labor and materials in order to complete the task. Work planning may give time frames limit but tasks given to the last planner would be according to their capacity of working (Forbes & Ahmed, 2010). Last Planner System applies the condition of “Should-Can-Will-Did” for better planning and control (Aziz & Hafez, 2013). It uses the different level schedules for this purpose as follows (G. Howell, 1999).

- a. The Master Schedule (SHOULD)
- b. The Look Ahead Schedule (CAN)
- c. The Weekly Work Plan (WWP) (WILL)

LPS suggests that at the end of every successive week, meeting should be called, where the results of WWP should be monitored to assess the percentage of work done “DID” during the week. And the tasks that couldn’t be completed should be justified with the reason. Continuous learning should occur by evaluating the mistakes during the last week and that learning should incorporate in the schedule of the next week. Percent of Plan Completed (PPC) should be computed using the formula given below(H. G. Ballard, 2000).

$$\text{PPC} = \text{DIDS} \div \text{WILLS}$$

2.5 APPLICATION OF LEAN CONSTRUCTION IN CONSTRUCTION INDUSTRY

Application of lean construction in construction industry is like a social change in the society. People in the industry must change their way of thinking, they have to think in a lean way. They must leave their old conventional methods and revolutionize their thoughts to bring lean atmosphere in the industry, which is of course not a piece of cake. Some prerequisites to apply lean construction in the industry are as follows.

- a. Readiness to adopt new philosophy
- b. Devotion to learning
- c. Quality oriented environment
- d. Shared Vision
- e. Willingness to eliminate waste
- f. Readiness to Performance and cost indicators
- g. Supportive relationships

h. Adoption of computer based technologies

These features are necessary in people of construction industry to adopt the lean construction (Forbes & Ahmed, 2010).

It's a rule of nature that change always comes from the top. Same is incorporated by Greg Howell that senior management of the organization has to first determine that they want change(G. A. Howell, 1999). Senior management has to convince every member of the team that what they are going to bring and why. In 1999 Glenn Ballard stated in "the challenge to change" that companies first have to commit to bring the change then some external consultant can be hired to transform the organization into lean organization(Ballard, 1999).

The main hurdle in implementation of lean construction is lack of knowledge. Due to the complex nature of the construction, every party involved should have a prior knowledge of lean manufacturing to understand the lean construction concepts (Bertelsen, 1993). Possible efforts should be made to learn about the lean construction to avoid any hurdle in its implementation in construction industry (Jorgensen et al., 2005).Leading change successfully requires necessary actions (Macomber & Howell, 2005). To bring change lean leaders have to direct or persuade their team to adopt new culture. Some actions necessary on this behalf are as follows (Forbes & Ahmed, 2010).

- a. Propagate that change will be in their benefits
- b. Portray all involved the justified criterion
- c. Make obvious the new culture
- d. Always appreciate new culture

- e. Play a practical role to bring change rare

Jay Berkowitz, President of Superior Window Corporation states that Lean without a passion is like a love lost relationship. He considers the “Passion” as a mandatory element in team to implement lean in their organization (Forbes & Ahmed, 2010).

Construction cannot be done in isolation. Construction firm has to remain in close coordination with other firms like suppliers, subcontractors etc. So, for successfully implementation of lean in any organization, we must have to teach the lean principles to those other firms too in order to create a Lean atmosphere. Without this we can fully apply the lean concepts because of the resistance offered by those organizations (Forbes & Ahmed, 2010).The profit and overall efficiency of construction can be improved using lean construction. Value addition, quality work in cheaper price and less time are the added advantages of using it. It increases the value by eliminating the non-value adding tasks/wastes. It emphasis on production and satisfaction and pleasure of client by achieving the required objectives(Forbes & Ahmed, 2010).

In addition, lean construction recommends the utilization of adequate resources at appropriate time. Lean construction works on production management philosophy which is essential for critical, uncertain and fast track projects(G. A. Howell, 1999).A summary of hurdles in lean implementation and possible solutions are identified and represented in Table 2.2 and 2.3 below:

Table 2.2: Barriers to lean construction implementation

Sr. No.	Hurdles in Lean Implementation	Reference
1	Reluctant to change	(Ballard, 1999)
2	Lack of commitment	(G. A. Howell, 1999), (Ballard, 1999)
3	Lack of Passion	(Forbes & Ahmed, 2010)
4	Lack of Expertise	(Pekuri et al., 2012)
5	Lack of Education and Training	(Bertelsen, 1993)
6	Lack of Appreciation	(Macomber & Howell, 2005)

Table 2.3: Solutions for lean construction implementation

Sr. No.	Solutions for Lean Implementation	Reference
1	Hiring an external consultant	(Howell & Ballard, 1998)
2	Trainings and seminars	(Jorgensen et al., 2005)
3	Personal meetings	(Macomber & Howell, 2005)
4	Institutional/governmental support	(Devaki & Jayanthi, 2014), (Forbes & Ahmed, 2010)

2.6 LEAN CONSTRUCTION ACROSSTHE WORLD

The proposal for the British construction industry to maximize the productivity and efficiency through the use of new techniques and improve the level of satisfaction pertains to (Egan, 1998). This idea welcomed the lean construction for value addition and enhance performance by reducing waste.

Being the challenge for the Malaysian construction industry, highlighted by the Master Plan of the Construction Industry (CIMP), 2006-2015, is access to cheap foreign manpower which hinders the utilization of advanced tools and a compromise on the productivity and quality of construction. The (CIMP), 2006-2015, recommended that Malaysian construction industry needs to get rid of conventional methods and go for advanced tools and techniques. Industry Professionals opted to adopt the lean construction basics to improve the productivity and quality. Nonetheless, the investigation of construction companies in Malaysia has proved that there is still a need to apply a more technical approach to the production system (Marhani et al., 2012).

Construction industry of Turkey is also experiencing different issues due to wastes. Study conducted by approaching 116 firms related to construction in order to investigate the various forms of wastes revealed that numerous factors causing the wastes in the industry can be coped with the application of lean philosophy (Polat & Ballard, 2004). Further, Swedish construction has faced many problems related to industrial productivity and waste production. There was a discussion in the industry that what to do to increase productivity and to eliminate the waste. But over the last few years, the construction sector has adopted lean principles in order to get rid of ongoing problems related to productivity and waste, which proved to be fruitful in this regard (Forsberg & Saukkoriipi, 2007).

RESEARCH METHODOLOGY

3.1 INTRODUCTION

Searching for knowledge scientifically to solve a problem is referred to as research. Research should be done in well-defined steps to discover the fact which was hidden before, through different approaches followed by sub-objectives of data collection and analysis (M. N. Saunders, 2011). This series of well-defined steps is called Research Methodology.

This research aimed at applying lean philosophy in construction industry of Pakistan by evaluating its application and benefits in different construction industries of the world. It uses both quantitative as well as qualitative approaches for implementation of lean in construction industry of Pakistan.

3.2 RESEARCH STRATEGY

Research strategy is affected by the aim and objectives set at the start of the research and the approach is fully dependent on the researcher which one to follow i.e. quantitative or qualitative (Gray, 2013). This research has four objectives as listed in Chapter 1. First objective is met with extensive review of pertinent published literature. Second objective is fulfilled using the quantitative approach, using the questionnaire. The population considered for examining the current practices of lean construction worldwide is the professionals from different countries where lean is partially or fully implemented in their construction industry. These countries include but not limited to USA, UK, Turkey, Canada, Italy and Germany. Meanwhile for

fulfilling of the third objective, qualitative approach in the form of personal interviews was applied. The population selected for examining the barriers to implement lean construction was the senior management of construction firms in the Pakistan. These firms include client, constructors, consultants, and architects. After analyzing the data of questionnaires and interviews, a solution to implement lean construction in the construction industry of Pakistan was proposed accomplishing the fourth objective. The flow chart of the research is presented in Figure 3.1.

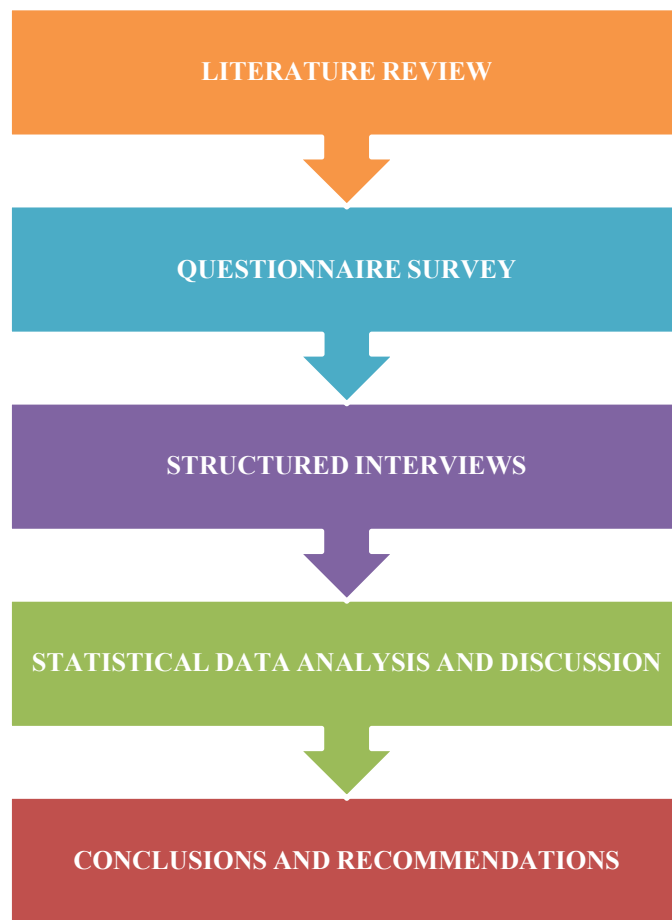


Figure 3.1: Research Flow Chart

3.3 QUESTIONNAIRE

Questionnaire is an organized way to approach stakeholders and information gathering through the questions in pre-organized way (M. Saunders et al., 2009). As discussed, in order to meet the objective of examining lean construction in different parts of the world questionnaire was used. Questions asked in questionnaire were of all types including open ended and multi choice. To get good response rate considerable efforts were made to prepare the questions that the respondents would be comfortable to answer. It was made clear and precise for the respondents to fill in, as suggested by (Wu et al., 2010). After thorough literature review, hurdles in implementation of lean construction practices were identified, in Table 2.1 and Table 2.2, and questionnaire was developed in accordance to those factors along with their possible solutions.

The questionnaire is divided into following sections

- a. The covering letter (indicating topic and its purpose)
- b. Respondents profile(ascertaining the right respondent)
- c. Body of questionnaire (Including questions regarding how lean construction is implemented in their countries and what are the results)

3.4 SAMPLE SELECTION AND SIZE

As lean construction is a new philosophy and less implemented in construction industries of the world so the “Convenience Sampling” technique suggested by Castillo (2009) was used for the purpose. As discussed, countries that have implemented lean construction in their construction industry partially or fully were taken for research purpose. Construction professionals from these countries were

approached through web based social network, and after initial discussion about their qualification, working experience and lean experience, they were requested to fill the questionnaires. These respondents were involved in lean in direct or indirect way in these countries. Taking responses through emails and social media is quite quick and suitable way for research purpose (M. Saunders et al., 2009). For 95% confidence and taking into account 10% sampling error, the sample size required was 96 (Dillman, 2000)

3.5 INTERVIEWS

Interviews enable detailed discussion on the subject topic with the respondent (Arksey & Knight, 1999). Interviews can be categorized as structured, semi-structured and unstructured. For evaluating the barriers in implementation of lean construction in construction industry of Pakistan, structured interviews were conducted in a very comfortable environment to enable the respondents to speak freely and in detail in order to extract maximum information. Although discussion was controlled to remain topic centered in order to have fruitful interview in permissible time of one-hour maximum. Interviews were tape recorded with the permission of the respondent. Questions in the interviews were purely related to respondent's view of hurdles in implementation of lean construction in Pakistan.

3.6 SAMPLE SELECTION AND SIZE

As the matter of the fact, change comes from top. Taking this fact into consideration interviews were conducted only from senior management of the Pakistan's construction firms. The constructors, consultants, designers and architects firm of Islamabad, Lahore and Karachi were interviewed. For the firms of Karachi,

telephonic interviews were conducted, but in Islamabad and Lahore, firms were personally visited. According to Alan Bryman of University of Leicester, for an interview based qualitative study 20-30 interviews are sufficient for sample size (Bryman, 2006). Prof. Ragin of University of Arizona further clarifies it and recommends sample size of 20 interviews for MS research work and 30 for doctoral studies (Ragin et al., 2006).

3.7 ANALYSIS OF DATA

The collected data was of two types, first for getting information about implementation and benefits of lean construction in different parts of the world using questionnaire and secondly gathering information about the hurdles in implementing lean construction in Pakistan using interviews. After collecting the data; Cronbach's alpha coefficient method was applied in order to address reliability. Data was checked for normal distribution by applying the normality test.

For the second purpose, data was analyzed using the techniques of Content Analysis. Content analysis is analyzing visual, written or oral communication (Cole, 1988). During content analysis, the main idea and keywords spoken by the interviewees were considered as the primary content.

DATA ANALYSIS AND RESULTS

4.1 INTRODUCTION

This chapter parades the data collected through questionnaires and interviews for quantitative and qualitative analysis respectively. Questionnaire survey was done in order to find out that how developed countries have implemented lean construction in their industry, what were the hurdles in doing so and how they have catered for these difficulties. Using the information gathered through questionnaire survey, further interviews were conducted with senior management of construction industry of Pakistan to discuss the practical problems and their respective solutions to implement the lean construction in construction industry of Pakistan.

4.2 QUESTIONNAIRES

Questionnaires were distributed among professionals working in different countries that have experienced in lean construction implementation in their construction industry out of which 205 professionals filled up the questionnaire, out of which 200 responses are considered valid after detailed scrutiny. Questionnaire was prepared using google type-forms and was floated to different people using social network, emails. Most of the respondents were having field experience more than 5 years. Versatile data can be collected through questionnaire survey as it provides an access to extensive number of people so a broader concept can be gained. Real life measures and experiences are also gathered using questionnaire survey (Yin, 2003).

4.2.1 CHARACTERISTICS OF RESPONDENTS

Out of 200 respondents most of the respondents were from developed areas e.g. 31 were from Turkey, 26 from USA etc. Detail of location of respondents is shown in Figure 4.1.

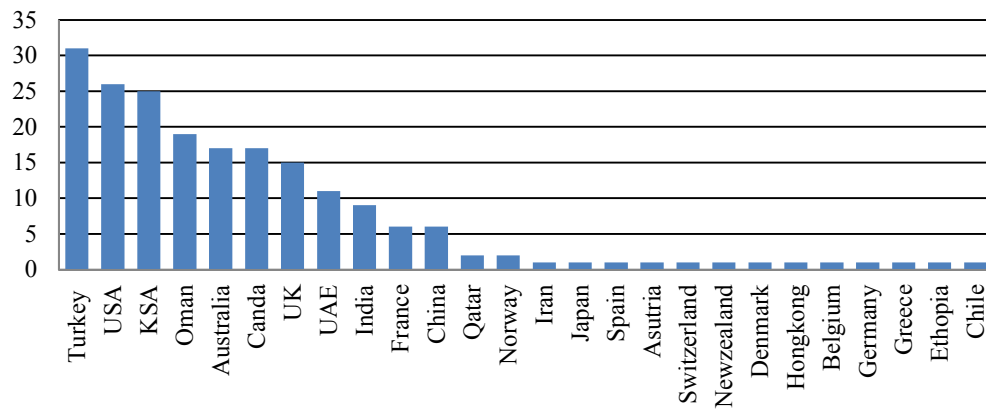


Figure 4.1: Location of respondents

65 % of respondents were from private sector of their construction industry whereas from government and semi government sector there were 18 and 17 % respondents as shown in figure 4.2.

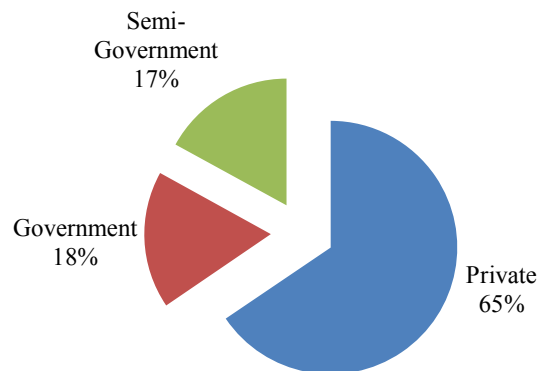


Figure 4.2: Nature of work organization

Figure 4.3 shows the experience of respondents with the construction industry. Most of the respondents were having experience between 6-10 Years i.e. 39%, 51 % of respondents were having experience of more than 10 years whereas only 10 % had experience of less than 5 years.

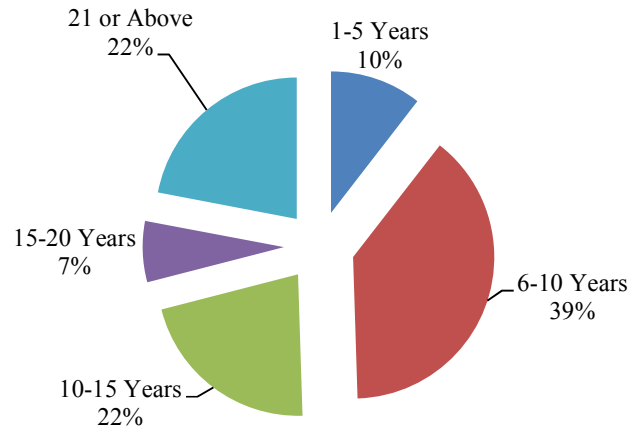


Figure 4.3: Experience of respondents

To check the understanding about lean construction, Respondents were asked on likert scale of very low to very high. 69 % of the respondents were between moderate to high, 10 % people have very high understanding where as 21 % people were having low to very low-level understanding of lean construction but are being involved in it. These are mostly the people who are new to lean construction or having less experience in construction industry.

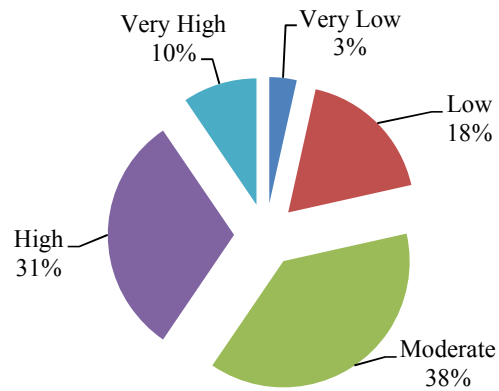


Figure 4.4: Understanding of lean construction

4.2.2 STATISTICAL ANALYSIS

To statistically validate the collected data, various tests were conducted for which the details are discussed below.

4.2.2.1 Reliability of the sample

For the checking of reliability of the data collected on likert scale, Cronbach's Alpha method is used. If the value of Cronbach's Alpha is greater than .7, the data is reliable. Further, if the value is greater than .9, the data is highly consistent for use (Li, 2007). The value of Cronbach's Alpha is .925 so the data is reliable.

4.2.2.2 Measurement of normality of data

For checking the normality of data, Shapiro -Wilk test was carried out as the sample size was less than 2000. This test was conducted to evaluate whether the collected data was normally distributed or not, i.e. the data was parametric or non-parametric. As per the results of normality test, the data is not normally distributed and non-

parametric test are needed to further analysis. Table 4.1 shows the results of Shapiro-Wilk test.

Table 4.1: Shapiro-Wilk test

S. No	Parameter	Statistic	df	Significance
1	Level of adoption of lean construction in your construction industry?	.889	200	.000
2	Do you think lean construction is a revolution in the construction industry?	.429	200	.000
3	Before: Over Budgeting	.860	200	.000
4	Before: Time Overrun	.871	200	.000
5	Before: Wastage of Materials	.853	200	.000
6	Before: Wastage of Potential of People	.878	200	.000
7	Before: Safety Issues	.899	200	.000
8	Before: Excessive Rework	.883	200	.000
9	Before: Lack of Coordination Between Stakeholders	.878	200	.000
10	Before: Lack of Client Satisfaction	.881	200	.000
11	What was the level of difficulty in overcoming the above hurdles?	.877	200	.000
12	After: Time Overrun	.806	200	.000
13	After: Wastage of Potential of People	.851	200	.000
14	After: Safety Issues	.836	200	.000
15	After: Excessive Rework	.841	200	.000
16	After: Lack of Coordination Between Stakeholders	.861	200	.000
17	After: Lack of Client Satisfaction	.857	200	.000
18	Did you adopt the pure lean construction philosophy or you have modified it according to your construction industry requirements?	.613	200	.000

4.2.2.3 Kruskal Wallis test for non-parametric data

Since the data collected for this research was non-parametric, Kruskal-Wallis test was used to check whether all respondents including government, Semi

government and private organization had similar perception regarding the factors affecting productivity.

Table 4.2: Kruskal Wallis test

Sr. No	Parameter	Significance
1	Level of adoption of lean construction in your construction industry?	0.49208
2	Do you think lean construction is a revolution in the construction industry?	0.74105
3	Before: Over Budgeting	0.73817
4	Before: Time Overrun	0.51154
5	Before: Wastage of Materials	0.67218
6	Before: Wastage of Potential of People	0.36070
7	Before: Safety Issues	0.41589
8	Before: Excessive Rework	0.3149
9	Before: Lack of Coordination Between Stakeholders	0.96423
10	Before: Lack of Client Satisfaction	0.66682
11	What was the level of difficulty in overcoming the above hurdles?	0.90879
12	After: Time Overrun	0.01601
13	After: Wastage of Potential of People	0.06370
14	After: Safety Issues	0.08794
15	After: Excessive Rework	0.52501
16	After: Lack of Coordination Between Stakeholders	0.06111
17	After: Lack of Client Satisfaction	0.00268
18	Did you adopt the pure lean construction philosophy or you have modified it according to your construction industry requirements?	0.85581

For most of the factors, the stakeholder's perception was same but for the following factors difference in perception was observed.

- a. After: Time Overrun
- b. After: Lack of Client Satisfaction

4.2.3 LEVEL OF ADOPTION OF LEAN CONSTRUCTION IN THEIR FIRM

When respondents were asked about level of adoption of lean construction in their workplaces, most of the people, almost 68 %, replied with moderate to High adoption level. 24 % replied with Low level and above high-level adoption there were 10 % respondents.

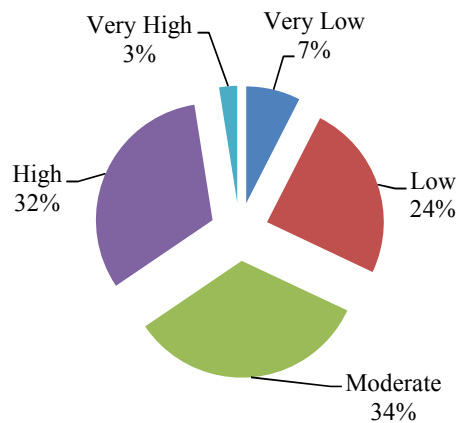


Figure 4.5: Level of adoption of Lean Construction in respondent's work places

4.2.4 REASONS FOR ADOPTION OF LEAN CONSTRUCTION

Time overrun, over budgeting and wastage of materials were the major causes which urged more than 50 % of the respondents to adopt lean construction. Excessive rework and lack of coordination between stakeholders were chosen by the 49 % and 39 % of respondents respectively.

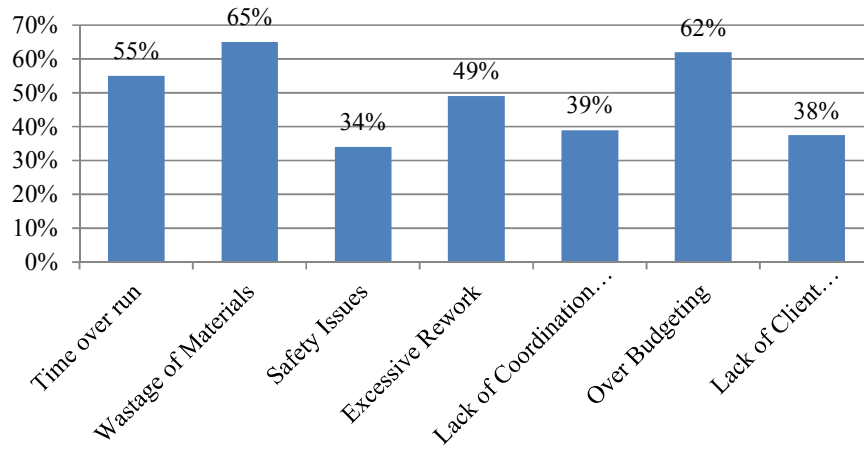


Figure 4.6: Reason for adoption of lean construction

4.2.5 LEAN CONSTRUCTION A REVOLUTION TO CONSTRUCTION

Respondents were asked if they consider a lean construction a revolution to construction, answer to which by most of the respondents, 85% were affirmative. Only 12 % do not think it a revolution and others were not sure about it.

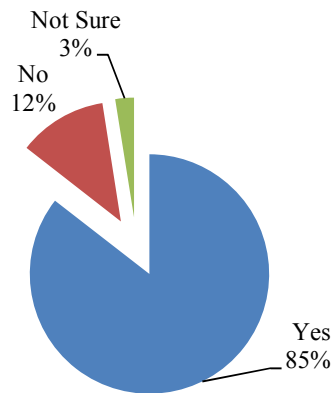


Figure 4.7: Lean construction a revolution for construction

4.2.6 EFFECTS OF IMPLEMENTING LEAN CONSTRUCTION

Respondents were asked about the effects of lean construction in their Industry by categorizing the different issues before and after application of lean construction. Likert scale from very low (1) to very high (5) was used. Results came out to be very positive as lean construction has coped with the issues of construction industry very well which confirms the motivation of lean construction. Figure 4.8 shows that construction problems are reduced from high scale to low scale after implementing lean construction.

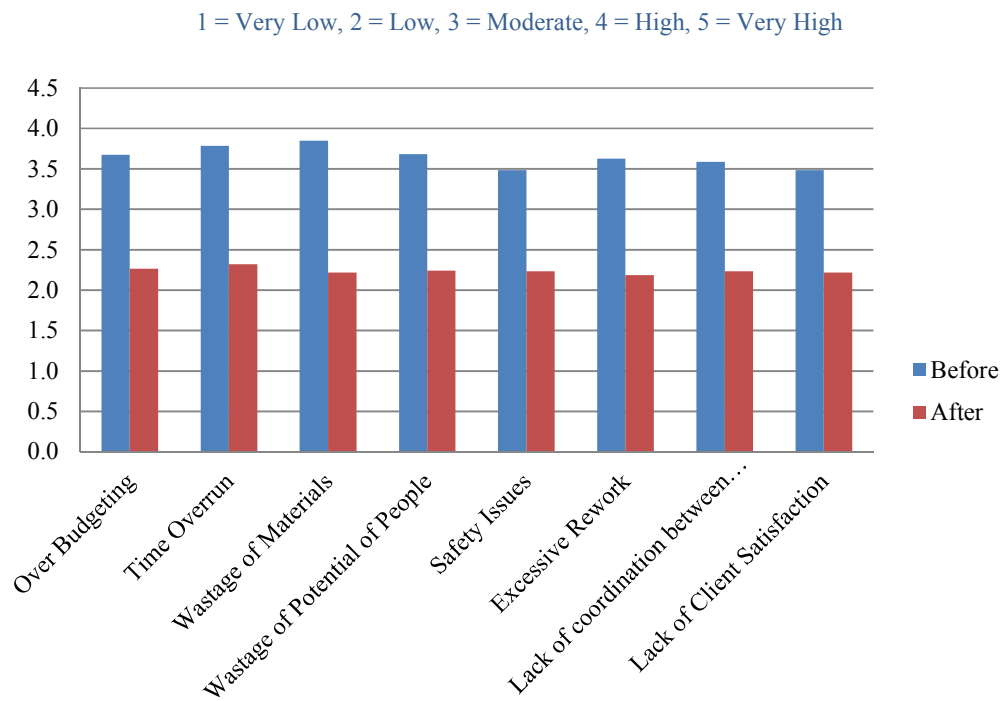


Figure 4.8: Effect of implementing lean construction

4.2.7 HURDLES IN IMPLEMENTING LEAN CONSTRUCTION

The biggest hurdle in implementation of lean construction faced by the respondents is reluctant to change (Kotter, 2009). Same is confirmed by 72 % of the

respondents. Lack of Expertise was the second biggest stumbling block in lean way as said by 58 %. Whereas Lack of Education and Training, Lack of Commitment, Lack of Passion, Lack of Resources and Lack of Appreciation was considered by 57 %, 46 %, 36 %, 34 % and 25 % of the respondents respectively as the hurdles in implementing lean construction in industry.

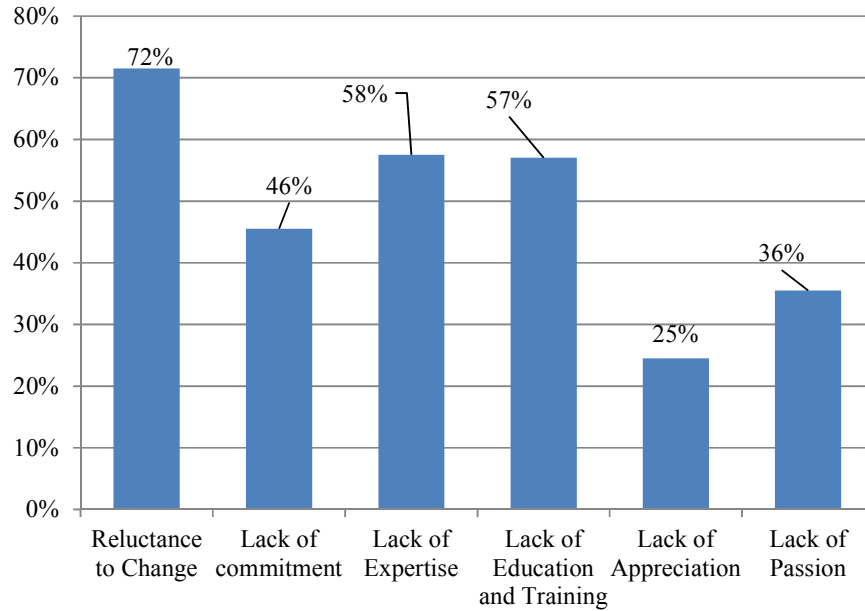


Figure 4.9: Hurdles in implementing lean construction

4.2.8 OVERCOMING THE HURDLES IN IMPLEMENTING LEAN CONSTRUCTION

In continuation of description of hurdles in lean construction implementation, respondents were asked that how they have overcome the hurdles described in section 4.2.7. 64 % of respondents replied in favor of seminars for awareness of lean construction and its benefits. 56% of respondents said that meeting with stakeholders and convincing them about lean is one of the ways one can use for overcoming the

hurdles in implementing lean construction. Hiring of External Consultant and Institutional/Government support was suggested by 43 % and 29 % of respondents.

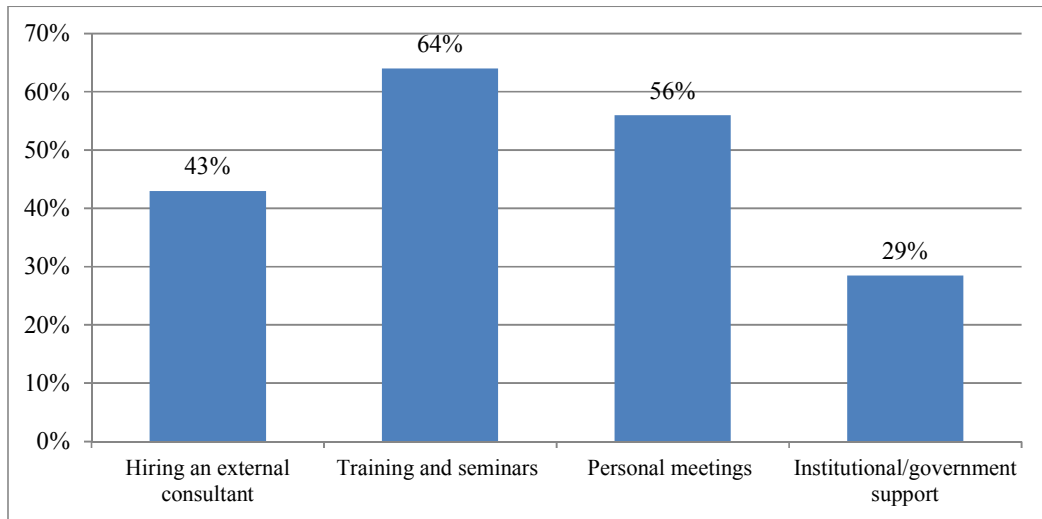


Figure 4.10: Overcoming the hurdles in implementing lean construction

4.2.9 LEVEL OF DIFFICULTY IN OVERCOMING THE HURDLES IN IMPLEMENTING LEAN CONSTRUCTION

Level of difficulty in overcoming the hurdles in implementing lean construction was investigated using likert scale from very low (1) to very high (5). Results show that to cope with the hurdles in lean construction implementation is not an easy task.

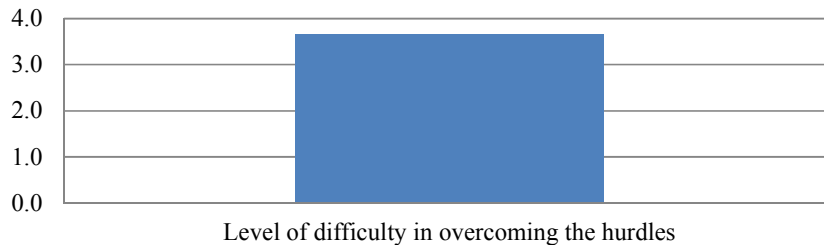


Figure 4.11: Level of difficulty in overcoming the hurdles in implementing lean construction

4.2.10 REACTION OF STAKEHOLDERS TOWARDS LEAN CONSTRUCTION

Respondents were asked about the reaction of the stakeholders during early implementation of lean construction. Major percentage 33% of the respondents said that they accepted it, while 29 % were of the opinion that stakeholders ignored it, while opposition and encouragement of lean construction by the stakeholders was submitted by 20 % of the respondents each.

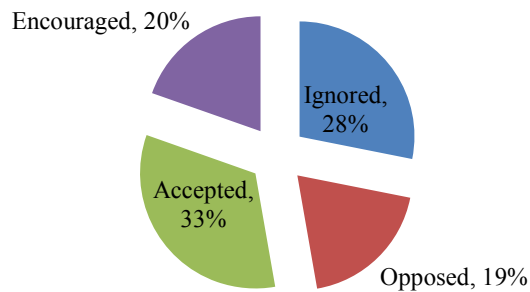


Figure 4.12: Reaction of stakeholder towards lean construction

4.2.11 ADOPTION OF LEAN CONSTRUCTION

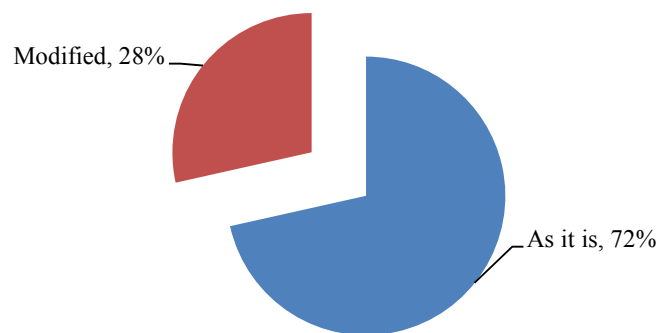


Figure 4.13: Adoption of lean construction

When respondents were asked that have they implemented lean construction as it is or they have modified as per current prevailing scenario of your construction industry. 72 % of respondent replied with “As it is” whereas 29% of the people modified the lean construction as per the requirement.

4.2.12 SUMMARY OF INFORMATION GATHERED THROUGH QUESTIONNAIRES

Lean construction philosophy is new in construction industry. Construction industries of the world are adopting this new concept in their construction processes. Its adoption is mostly in developed countries. Only 3 % of respondents said that their firms have adopted lean construction in very high level but major percentages were between low to high which shows that construction industries of the world are changing their mindset and becoming lean in gradual and continuous process.

The major reasons for adoption of lean construction in international construction industries were time over run, over budgeting and wastage of materials. Survey indicated that 85 % of the respondents consider that lean construction is a revolution to construction industry and can cope with the above-mentioned problems of the projects. Same has been confirmed by investigation of effects of implementation of lean construction that before implementation the problems were categorized by the respondents as “High” but after implementation the problems were classified as “Low”.

As per the questionnaire results, during implementation of lean construction the biggest problem encountered was the hesitant behavior of human to change. A next major issue was lack of expertise, education and training. Along with other

issues, Lack of commitment and passion was also the prominent hurdles faced by construction industries of the world.

As far as the above-mentioned problems during implementation are concerned, respondents suggested that training and seminars of lean construction awareness and its benefits is the best tool to overcome them. Meeting with stakeholders and convincing them personally and hiring of an external consultant are some other tools which can be used to overcome the hurdles. Governmental support is also very much necessary in this regard. Also, it is not easy task to overcome the hurdles stated above, survey reveals that level of difficulty in overcoming the hurdles in implementing lean construction is “High”. But there is nothing to worry about as Survey also revealed that during early stage of implementation only 19% of the people opposed it which were comfortable with the older techniques of project delivery other wise 33% accepted it, 20 % even encouraged it, 28 % were the people who ignored it, meaning that they were neutral about it.

The last question in survey was the nature of implementation of lean construction, whether lean construction was adopted as it is or it has been modified as per current prevailing scenario of construction industry. 72 % of the respondent confirmed “as it is” whereas at some part (28%) of industry it was implemented after minor modification as per the requirement.

4.3 INTERVIEWS

This section aims to explore the findings of interviews done in order to find the hurdles with their relevant solutions to implement the lean construction in Pakistan. The interviews were conducted with total of 20 personnel from all over the

Pakistan comprising of constructors, designers and architects. These professionals were serving at the senior management and middle management positions in private, semi government and government agencies. Widespread interviews were conducted in order to get authentic information about the implementation of lean construction in Pakistan. Interviewees were given a topic not the questions to speak openly, afterwards technique of content analysis was used at both descriptive and interpretative levels. The list and profile of personnel is shown in Table 4.3.

Table 4.3: Profile of interviewees

Interviewees	Organization	Designation	Qualification	Experience
1	Izhar Construction	Senior Resident Engineer	BSc (Civil)	15
2	Tahir Builders	Project Manager	B.Tech (Civil), MPM, PMP	21
3	Habib Rafiq Pvt Ltd	Senior General Manager	BSc (Civil), MS (Structures)	26
4	Habib Rafiq Pvt Ltd	General Manager	BSc (Civil)	44
5	Capital Development Authority	Assistant Director	BSc (Civil) MS (Structures)	7
6	NESPAK	General Manager	BSc (Civil)	35
7	Progressive International	Managing Director	BSc (Civil), MS (Water Resource)	29
8	Anwar Ali and Associates	Principal Architect	B.Arch	42
9	Habib Rafiq Pvt Ltd	Project Manager	DAE (Civil)	48
10	Anwar Ali and Associates	Resident Engineer	BSc (Civil)	47
11	NESPAK	Chief Resident Engineer	BSc (Civil), MBA	40
12	NLC	Project Manager	BSc (Civil)	22
13	Banu Mukhtar Pvt Ltd	General Manager	BSc (Civil), PMP	22
14	Izhar Construction	Senior General Manager	Bsc (Civil)	28
15	NESPAK	Resident	BSc (Civil)	16

		Engineer		
16	Descon	Construction Manager	BSc (Civil)	18
17	Paragon Construction	Project Director	BSc (Civil)	19
18	Paragon Construction	General Manager	BSc (Civil), MS	27
19	Suhail and Fawad	Principal Architect	B.Arch	42
20	Capital Development Authority	Member Engineering	BSc (Electrical), MS (Electrical)	34

4.3.1 HUMAN ISSUES

One of the prerequisite to implement lean construction in industry is willingness to change (Forbes & Ahmed, 2010). Survey revealed that 72% of the respondents regarded reluctance to change is the biggest problem which hinders the implementation of lean construction. Human related issues were investigated through interviews in order to find out the construction professional's mindset in implementation of lean in Pakistan's construction industry. In Pakistan, talented and experienced persons comprise the senior management department of construction industry where all policies are made. In Past, when the projects were not so complex or there was no scarcity of resources, traditional project management was enough to deliver the projects till acceptable limits. As the world has progressed and new technologies and philosophies of construction are essential to muddle through the challenge of complex projects and constraints; interviews revealed that ideology of Pakistan's construction industry professionals hasn't changed and they still feel comfortable with old traditional methods and even considers the technology advancement a complexity in delivering the projects.

All the interviewees appreciated the lean construction concept and confirmed that it should be implemented in construction industry of Pakistan to deal with the current issues but when they were asked, *will they be the part of team who will work for implementation of lean construction in industry?* Except few interviewees, all excused for the purpose saying that they are fully occupied by their jobs and cannot extract time to indulge their selves in any other activity. In short everyone was interested in change but with few exceptions, none was ready to bring the change, which shows the lethargic attitude of industry's professionals. This reluctant behavior to change is the main hurdle in implementation of lean construction in Pakistan as it requires change in management process by change in leadership thinking (Kotter, 2009).

This impediment is almost faced everywhere in the world when they tried to go lean but is more specific to the developing countries. In India, a research was undertaken to implement lean principles in Indian construction industry by Devaki and Jayanthi (2014) whereby they identified the cultural mindset as one of the major barriers in implementing lean construction, people do not want to drive the project on the new path. This kind of professional's thinking could be bearable in past, but today when there is a frequent depletion of world resources and is massive inflation, we need to rethink in a line of attack that reduces waste reduction in construction processes to make projects economical and even better control on world pollution, as bulk of waste is contributed by the construction sector.

4.3.2 CULTURE OF THE INDUSTRY

Lean is more about organizational behavior than a set of tools (Womack, 2007). Even implementation of lean requires a culture which focuses on human and

empowers the stakeholders of organization to take steps that can improve productivity by reduction of wastes in the processes and continuous learning (Hines & Found, 2008). Information gathered from interviews about the culture of construction industry was very alarming. Interviewed professionals did not appreciate learning, self-confidence and creativity in general. There is paucity of leadership in bringing a change; all are busy in safeguarding their own personal interests. There is a self-centered thinking of people in the industry; lack of respect giving culture dominates in the industry. Decisions are made by senior management and are thrown over the wall to the downstream players; downstream players are not involved in decision making process. There is no concept of succession planning in the industry. There is a long process of every approval and decision in government departments, which consequences in the late delivery of project. Government policies are not suitable for local construction industry. Due to unstable political situation, there is no continuity in construction.

Survey revealed that 20% of the people opposed lean construction implementation and 29% of the people simply ignored it. They are the people who do not accept anything new in the industry because of their personal interests. Summarizing the interviews regarding the cultural issues, overall culture of industry does not support the development of new concepts. This type of culture is the main challenge to implement lean in construction industry (Liker, 2004). Implementation of lean is an organizational strategy regarding the change of culture with the passage of time by gradually implementing lean tools that are occasionally suitable. This can also be referred to as the lean journey (Hines & Found, 2008).

4.3.3 NON-STANDARDIZED CONSTRUCTION

Lean construction has been emerged from manufacturing techniques(Lauri Koskela & Greg Howell, 2002). Manufacturing is standardized business where constant standards are followed most of the times. This facilitates the implementation of Just in time theory in its process. To implement lean principles in construction industry we need to standardize our construction. But unfortunately, in Pakistan designers are unaware of importance of standard materials (Interviewee 20). Materials in the industry should be standardized in order to ensure the easy access in lesser time (Interviewee 7). Standardization of materials can lead to better adoption of *Just in Time* concept and can eliminate the inventory wastes (Interviewee 20). Raw material of construction should be manufactured in pre-defined different sizes and designs; designers should be well aware of all these varieties and they should design the facility keeping in mind the easy availability of these raw materials.

4.3.4 LACK OF EDUCATION, AWARENESS AND PAKISTAN ENGINEERING COUNCIL

As per the survey, 57% of the respondents confirmed that Lack of education and training is the main hurdle in lean construction application. Construction industry of Pakistan requires professionals. People are educated but not qualified for the job. They are educated on an traditional ways, there is no renovation in our education system, engineer of 80's and engineer of 2015 have read the same course during his engineering (Interviewee 1). Engineers are not aware of up-to-date knowledge or techniques being implemented in other parts of the world (Interviewee 11). There is ill thought out measure of performance of seniority in the field i.e. no of years of experience; people are not evaluated on their competence (Interviewee 3).

Pakistan Engineering Council (PEC) is not playing any vital role in this regard. PEC should play role in order to bring advancement in the industry. They should conduct awareness seminars about the new trends in the world and should make compulsory for every engineer to attend it. Lean construction should be the part of CPD course (Interviewee 2). As per the survey results, 29 % of the respondents also stated that they have overcome the hurdles in implementation of lean construction though institutional/governmental support, for Pakistan this institution is of course the Pakistan Engineering Council. People in the field are not realizing the benefits of adopting new technologies which is the main hurdle in lean implementation (Interviewee 17).

Survey also indicated that training and seminars on awareness of lean construction and its benefits is the useful way in this regard. A pilot project under the guidance of PEC should be constructed in which lean construction may be implemented practically in all respects and all the industry stakeholders should be called for observation and after all results of this project should be published and shown to all stakeholders of industry to clearly understand and realize the benefits of lean construction (Interviewee 16). PEC should promote the lean construction in Pakistan. PEC should develop a special institution who should work on lean construction implementation in Pakistan (Interviewee 16).

The most of important reason of lack of knowledge in the field is the uneven distribution of knowledge between academic and industry sectors. Bulk of knowledgeable persons is available in academics, whereas there is no or very little expertise in field (Interviewee 5).

4.3.5 FINANCIAL ISSUES

There is a major difference in express law and implied law of Pakistan. According to PPRA rules, contract should be awarded to the best value bidder, but in Pakistan, client always selects the lowest bid by arguing that we do not want to get indulged in afterwards audit by the department. This ultimately suffers the quality of construction work in industry (Interviewee 6). People in the industry cannot bear little investment to bring change, as every change requires investment in start (Interviewee 3). This is also due to the reason that people are not certain about the profits that they can achieve by little investment (Interviewee 7).

Due to financial constraints, contractors have to use the old and unsuitable machinery for the construction process resulting into loss of effort and time, ultimately increase in overall cost with decrease in profit (Interviewee 9). Client should purchase the machinery for the project in order to facilitate the contractor for better productivity and less wastage and can deduct the depreciation charges of equipment from the contractor bills (Interviewee 17).

4.3.6 IMMATURITY OF CONSTRUCTION FIRMS

Due to high influx of business in construction sector, undeveloped personals are getting involved. In Pakistan, there are very few firms who have more than 30 years of experience in construction, remaining all firms are new and immature in this respect (Interviewee13). There is lack of corporate culture enabling the traditional methods easy to implement and stumbling block the advancement in construction industry (Interviewee 6). One-man show is observed mostly in all the construction firms, which impedes the intrusion of lean construction concepts in Pakistan.

(Interviewee7). The capitalist sitting at the top of the management has nothing to do with the profession of the construction, what he cares is the profit; lean construction enhances the profits but unlike the construction industries of other part of the world, we have not realized its importance till yet (Interviewee 19).

4.3.7 CONSTRUCTION CONTRACTS

All over the Pakistan in the construction industry, FIDIC contracts are used. There is no concept of lean construction or no support of advancement in construction industry in FIDIC contracts (Interviewee 5). Contract should allow all the stakeholders to add the value in the project enabling every stakeholder on the same page of project interests (Interviewee 3). There is nothing in the contract and even in PEC conditions of contract about the relationship of stakeholders working on the project. Cooperation between the stakeholders and partnering should be the part of the contract and should made compulsory to each stakeholder to cooperate with each other for better interest of the project in order to successfully implement lean construction in industry of Pakistan (Interviewee 6).

4.3.8 HURDLES DUE TO OTHER ORGANIZATIONS

The most adopted system of bidding in Pakistan is Design Bid Build where, designer designs the product and contractor build the project after award of the contract. This leads to imperfect designs, sometime, because of absence of consent of builder in design phase. Engineering Procurement and Construction (EPC) type of contracts should be promoted in construction industry of Pakistan to avoid these troubles (Interviewee 7).

The construction industry of Pakistan is running on an un-mechanized system (Interviewee 8). If any organization brings change in itself and wants to do quality work in lesser time, other organizations comes in between by unnecessary delays e.g. un- necessary delays are often experienced in responding to Request for Information by the consultant (RFIs) (Interviewee 17). Material suppliers do not deliver the material on time or delivers the sub-standard material. There is lack of coordination between the contractors and material suppliers due to late payments by the contractors which is the result of late payment to the contractor by the client (Interviewee 7). People work for their own organization interest; industry lacks in partnering concept (Interviewee 3). Partnering should be ensured by the client in each and every project in order to successfully implement lean construction (Interviewee 13). The organizations who wish to adopt the lean construction should promote it to their competitors as well, so as to face low resistance (Forbes & Ahmed, 2010).

DISCUSSIONS, FUTURE RESEARCH AND

CONCLUSIONS

5.1 INTRODUCTION

This section concludes the research analysis and findings. Summary of data collection and analysis in previous chapters is summarized. Recommendations based on study and results are presented. Detailed strategy is to implement lean construction in construction industry of Pakistan.

5.2 RESEARCH FINDINGS AND CONCLUSIONS

In line with the main focus of this study, challenges faced in implementation of lean construction in other countries were identified. Followed by possible ways to implement lean construction in construction industry of Pakistan to improve the overall performance and reduce the waste involved in different processes.

The objectives of this study were firstly achieved through literature review by elaborating the problems being faced by the overall construction industry of the world. Chapter 2 discusses in detail the results of using conventional methods of construction which neither are for nor doubt very drastic i.e. time consuming and generating wastage in every process of construction industry and ultimately failure in the project.

Lean construction is different from traditional approach of project delivery, as traditional approach focuses on activity management but lean construction is the

production management approach. Wastes in the process was presented (Forbes & Ahmed, 2010), lean principles presented by Womack and Jones (1996) as well as Lean Project Delivery System (LPDS) developed by G. Ballard (2000) was also elaborated. Furthermore, it was also elaborated that how we can apply lean construction in construction industries and different barriers encountered in its implementation. Lean construction can also be implemented in Pakistan as it is being successfully used by different construction industries of the world and those construction industries are reaping its benefits.

Survey was conducted from the international construction industry to find out the benefits hurdles and their possible solutions in implementation of lean construction in construction industry. Survey revealed that, time overrun, cost overrun and wastage of materials are the biggest reasons that urged them to go for lean construction. 85 % of respondents declared lean construction a revolution to construction industry. Majority of respondents ranked the above-mentioned issues on likert scale as “High” before lean construction implementation and “low” after its implementation. Survey also indicated the Human Reluctant behavior to change as the biggest problem along with others in lean construction implementation and suggested that creating awareness of lean construction is the best tool along with other tools for its successful implementation in construction industry. Survey also revealed that in some countries there were some minor modifications made to lean construction concepts as the requirement of locality and culture of the industry.

On the basis of information gathered through survey, interviews were conducted from the senior management, who are actually the policy makers, of the construction industry of Pakistan to find out that like other construction industries

what possible hurdles can be faced by the Pakistan's construction industry and how we can cope with these problems in order to successfully implement the lean construction in Pakistan.

Majority of the interviewees are of the view that there is lack of knowledge about the new and modern fields. According to them, institutional support is necessary for implementation of lean construction. Institutions will support lean construction and will work on training/basic knowledge and awareness. Successful implementation requires special attention of senior managements of all the stakeholders of industry; it needs revision in philosophy and principles of construction industry by proper planning.

5.3 RECOMMENDATIONS

Recommendations for efficacious implementation of lean construction in construction industry of Pakistan for coping with the current scenario of problems so that the projects can be delivered better and performance of construction industry can be increased are presented below:

- a. Governmental support is very much necessary which would motivate the stakeholder of the construction industry to adopt lean project delivery methods in their processes. There is a need to adopt lean construction in procurement and execution of projects.
- b. Research and development should be promoted
- c. Academic-Industry gap needs to be eliminated.
- d. Seminars should be conducted on awareness and to educate the stakeholders of lean construction philosophy and its benefits.

- e. Training on lean construction tools would be very beneficial in successful delivery of projects.
- f. Standardization in construction processes should be promoted to reduce uncertainty.
- g. Pakistan Engineering council should play a vital role in its implementation and make a permanent body who should work for successful implementation and further development of lean construction as per the requirement of Pakistan.
- h. Lean culture should be promoted i.e. bossy culture should be reduced by introducing leadership qualities in the managers. Every relevant person should be involved in decision making. Throwing the decision over the wall culture should be eliminated.
- i. Use of modern techniques and tools should be appreciated.
- j. Commitment of senior management in implementation of lean construction would play vital role.
- k. The management of the company should motivate the “Value Oriented” approach in their employees.
- l. Successful implementation of lean construction in construction industry of Pakistan requires the practical and adequate road map.

5.4 PLAN FOR SUCCESSFUL IMPLEMENTATION OF LEAN CONSTRUCTION IN PAKISTAN’S CONSTRUCTION INDUSTRY

Change is mostly intentional but sometimes it is unexpected too as it transforms from one structure to another gradually (Baker, 2007). The success of change is always relying on the commitment and reaction of the stakeholders (Kotter,

2009). Change definitely needs a proper plan to maintain its success in the environment so that challenges for its implementation can be minimized. In the same lines, proper strategy for implementation of lean construction in construction industry of Pakistan is necessary. This proposal for providing guidelines taking into consideration the information collected about Pakistan's construction industry culture from interviews will be of three stages.

In the very first step, Pakistan Engineering Council (PEC) should take steps and show commitment towards lean culture implementation. For this sake PEC should engage a team or create an association of experts solely for this purpose. The members of this association should be from both academic and industrial sides. This team should study the current project delivery approaches being implemented in construction industry thoroughly to find out the issues prevailing with the current methods. This team should train professionals of the industry; seminars can be conducted for this purpose which should be mandatory for all the engineers to attend. Lean construction should be introduced in the curriculum in academics institutes at undergraduate and graduate level. In short, we must first build a team of professionals who are sincere and committed to bring the change.

After this team built up, the next step would be the direct interaction with the stakeholders of the industry. This team will motivate and encourage the organizations to introduce lean construction in their processes. They would make it easier for the firms to take into look at advantages of lean construction. This would gradually create the overall environment producing competition in market. This team will also take care that successful firms should share their success stories with other organizations in order to overall culture should become self-supportive to lean construction.

Finally, once the advantages of lean construction implementation would be witnessed by the firms, and then would be the need to maintain this change. For that sake, the association can propose a strategy to Pakistan Engineering council to make it a provision of contract and be made mandatory for all the government, semi government and private procuring agencies to include this mandatory provision in their contracts with other organization and abide in true letter and spirit. Regular monitoring and supervision will be performed by the association to ensure its stabilization and continuous improvement as per the prevailing needs of the industry.

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Implementation and Benefits of Lean Construction in Construction Industry

Respected Sir / Dear Fellows,

Construction Industry has always been significant to the country in terms of both economic and social aspects. Unfortunately, its prospective share in the local and global economic market reveals that the development of this sector has not been at par with the market demand. This research aims to evaluate critical success factors for implementing Lean Construction philosophy in construction industry. As a part of this research, questionnaire has been developed and is being distributed among professionals having knowledge and experience of real-life projects in a construction industry.

Your feedback will help us understand the practical hurdles and problems being faced by construction industry in order to apply lean principles. It will help in overcoming all these issues and achieving better and fruitful results without wasting time, money and other resources.

I am Adeel Shehzad, MS student of Construction Engineering and Management department at National Institute of Transportation, School of Civil and Environmental Engineering, National University of Science and Technology at Sector H-12 Islamabad, Pakistan.

* Required

1. Your Name *

2. Origin (Country) of Your Organization *

Mark only one oval.

Option 1

3. Nature of Your Organization *

Mark only one oval.

Government

Semi-Government

Private

4. For how many years you have been associated with the construction Industry? *

Mark only one oval.

1-5 Years

6-10 Years

10-15 Years

16-20 Years

21 or Above

5. Level of Understanding about lean construction? *

1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

6. Level of adoption of lean construction in your construction industry? *

1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High
Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

7. Reasons for adopting lean construction. *

Check all that apply.

- Over Budgeting
- Time Overrun
- Wastage of Materials
- Safety Issues
- Excessive Rework
- Lack of Coordination between Stakeholders
- Lack of Client Satisfaction
- Other: _____

8. Do you think lean construction is a revolution in the construction industry? *

Mark only one oval.

- Yes
- No
- Other: _____

9. Please rank the following issues before application of lean construction in your industry. *

1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High
Mark only one oval per row.

	1	2	3	4	5
Over Budgeting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time Overrun	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wastage of Materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wastage of Potential of People	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Safety Issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Excessive Rework	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Coordination Between Stakeholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Client Satisfaction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

10. What were the hurdles in adopting lean construction? *

Check all that apply.

- Reluctance to Change
- Lack of Commitment
- Lack of Passion
- Lack of Expertise
- Lack of Education and Training
- Lack of Appreciation
- Other: _____

11. How did you overcome the hurdles described above? *

Check all that apply.

- By hiring an external consultant
- By training and seminars for awareness of lean construction and its benefits
- By personal meetings with stakeholders and convincing them about lean
- By institutional/government support
- Other: _____

12. What was the level of difficulty in overcoming the above hurdles? *

1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High

Mark only one oval.

	1	2	3	4	5	
Very Low	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Very High

13. How did the stakeholders respond to lean construction philosophy during implementation phase? *

Mark only one oval.

- They ignored it
- They Opposed it
- They accepted it
- They encouraged it
- Other: _____

14. Did you adopt the pure lean construction philosophy or you have modified it according to your construction industry requirements? *

Mark only one oval.

- As it is
- Modified
- Other: _____

15. Please rank the following issues after application of lean construction in your industry. *

1 = Very Low, 2 = Low, 3 = Moderate, 4 = High, 5 = Very High

Mark only one oval per row.

	1	2	3	4	5
Over Budgeting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time Overrun	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wastage of Materials	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wastage of Potential of People	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Safety Issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Excessive Rework	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Coordination Between Stakeholders	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lack of Client Satisfaction	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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